

1           What is claimed is:

2        1. In a data processing system including at least one client, a first file server coupled  
3           to the client for data access of the client to at least one file in the first file server, and at  
4           least a second file server coupled to the first file server for data access of the second file  
5           server to the file in the first file server, the second file server being programmed with a  
6           virus checker program, the virus checker program being executable by the second file  
7           server to perform an anti-virus scan upon file data in random access memory of the  
8           second file server, a method comprising:

9                  the first file server responding to a request from the client for access to the file in  
10               the first file server by determining that an anti-virus scan of the file should be performed,  
11               and initiating the anti-virus scan of the file by sending to the second file server a request  
12               for the anti-virus scan including a specification of the file, and then

13                  the second file server responding to the request for the anti-virus scan by invoking  
14               the virus checker program to perform an anti-virus scan of the specified file by obtaining  
15               file data of the file from the first file server and storing the file data of the file into the  
16               random access memory of the second file server and performing the anti-virus scan upon  
17               the file data of the file in the random access memory.

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19        2. The method as claimed in claim 1, wherein the first file server determines that the  
20               anti-virus scan of the file should be performed when the client requests the first file  
21               server to open the file and the first file server finds that the file has not been checked for  
22               viruses.

23

1       3.     The method as claimed in claim 1, wherein the first file server determines that the  
2           anti-virus scan of the file should be performed when the client requests a file to be closed  
3           after the client writes to the file.

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5       4.     The method as claimed in claim 1, wherein the first file server applies a filter to a  
6           file extension of the file to determine that the anti-virus scan of the file should be  
7           performed.

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9       5.     The method as claimed in claim 1, wherein the first file server blocks clients from  
10          accessing the file from the time that the first file server determines that the anti-virus scan  
11          of the file should be performed until the anti-virus scan is completed and fails to find a  
12          virus in the file.

13

14       6.     The method as claimed in claim 1, wherein the first file server determines that an  
15          additional anti-virus scan of the file should not be performed in response to the access of  
16          the file by the virus checker program.

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18       7.     The method as claimed in claim 1, wherein the first file server maintains in  
19          nonvolatile memory an indication of files that have not been checked for viruses, an  
20          indication of files that are in the process of being checked, and an indication of files that  
21          have been found to contain viruses.

22

1       8.     The method as claimed in claim 1, wherein the request for the anti-virus scan  
2     including a specification of the file is an Open Network Computing Remote Procedure  
3     Call.

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5       9.     The method as claimed in claim 1, wherein the second file server receives the  
6     request for the anti-virus scan and indirectly invokes the virus checker program by  
7     reporting a file access event to an operating system of the second file server, and the  
8     operating system of the file server responds by invoking the virus checker program to  
9     perform the anti-virus scan of the file.

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11      10.    The method as claimed in claim 1, wherein the operating system of the second file  
12     server supports processes executing in a user mode and processes executing in a kernel  
13     mode, and a server for virus checking executing in the user mode receives the request for  
14     the anti-virus scan from the first file server and forwards the request to a virus checker  
15     initiator driver executing in the kernel mode, and the virus checker initiator driver  
16     executing in the kernel mode initiates a file access event, and the virus checker program  
17     initiates the anti-virus scan of the file in response to the virus checker initiator driver  
18     initiating the file access event.

19

20      11.    The method as claimed in claim 10, wherein an input/output manager in the  
21     operating system of the second file server receives a file access call from the virus  
22     checker initiator driver, and responds by directing a report of the file access event to the  
23     virus checker program.

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2       12.     The method as claimed in claim 1, wherein the data processing system includes at  
3           least a third file server coupled to the first file server for data access of the third file  
4           server to the file in the first file server, the third file server also being programmed with a  
5           virus checker program that is executable by the third file server to perform an anti-virus  
6           scan upon file data in random access memory of the third file server, wherein the first file  
7           server performs a load balancing procedure to select one of at least the second file server  
8           or the third file server to perform an anti-virus scan of the file when the first file server  
9           determines that an anti-virus scan of the file should be performed.

10

11       13.     A method of operating a network file server to initiate a virus scan upon a file  
12           stored in the network file server, the network file server being coupled to at least one  
13           client for access of the client to at least one file in the network file server, the network file  
14           server being coupled to a plurality of secondary servers for access of the secondary  
15           servers to the file stored in the network file server, the network file server including a  
16           cached disk array and a plurality of data mover computers coupled to the data network  
17           and coupled to the cached disk array for responding to client requests for data access to  
18           storage in the cached disk array, each secondary server being programmed with a virus  
19           checker program executable for performing an anti-virus scan upon file data in random  
20           access memory of said each secondary server, a method comprising:

21               at least one of the data movers in the network file server responding to a request  
22           from the client for access to the file in the network file server by applying a filter upon a  
23           file extension of the file upon opening or closing of the file to determine that an anti-virus

1 scan of the file should be performed, and initiating the anti-virus scan of the file by  
2 applying a load balancing procedure for selecting one of the secondary servers for  
3 performing the anti-virus scan of the file, and sending to the selected secondary server a  
4 request for the anti-virus scan including a specification of the file, and then  
5 the selected secondary server responding to the request for the anti-virus scan by  
6 invoking the virus checker program in the selected secondary server to perform an anti-  
7 virus scan of the specified file by obtaining file data of the file from the network file  
8 server and storing the file data of the file into the random access memory of the selected  
9 secondary server and performing the anti-virus scan upon the file data of the file in the  
10 random access memory of the selected secondary server.

11

12 14. The method as claimed in claim 13, wherein the file is an executable file, and the  
13 network file server determines that the anti-virus scan of the file should be performed  
14 when the client requests the network file server to open the file and the network file  
15 server finds that the file has not been checked for viruses, and the network file server also  
16 determines that the anti-virus scan of the file should be performed when the client  
17 requests the file to be closed after the client writes to the file.

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19 15. The method as claimed in claim 13, wherein the selected secondary server  
20 receives the request for the anti-virus scan and indirectly invokes the virus checker  
21 program by causing an operating system of the selected secondary server to invoke the  
22 virus checker program in the selected secondary server to perform the anti-virus scan of  
23 the file.

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2       16. In a data network including a first server and a second server, the second server  
3       being coupled by a data network to the first server for access of the second server to at  
4       least one file stored in the first server, wherein the second server is programmed with an  
5       operating system supporting processes executing in a user mode and processes executing  
6       in a kernel mode, the operating system of the second server including an input/output  
7       manager executing in the kernel mode, a method of operating the second server to  
8       perform an anti-virus scan upon the file in the first server, said method comprising:

9                 a server for virus checking executing in the second server in the user mode

10          receives from the network a request for the anti-virus scan upon the file, and then

11                 the server for virus checking forwards the request to a virus checker initiator

12          driver executing in the second server in the kernel mode, and the virus checker initiator

13          driver responds to receipt of the request by sending a file access call to the input/output

14          manager, and then

15                 the input/output manager responds to the file access call by directing a report of a

16          file access event to a virus checker program executing in the second server in the user

17          mode, and the virus checker program responds by obtaining file data from the file in the

18          first server and storing the file data in random access memory in the second server, and

19          performing an anti-virus scan upon the file data in the random access memory in the

20          second server.

21

22       17. In a data processing system including at least one client, at least one network file  
23       server coupled to the client by a data network for access of the client to at least one file in

1       the network file server, and a plurality of NT file servers coupled to the network file  
2       server by the data network for data access of the NT file servers to the file in the network  
3       file server, the network file server including a cached disk array and a plurality of data  
4       mover computers coupled to the data network and coupled to the cached disk array for  
5       responding to client requests for data access to storage in the cached disk array, each of  
6       the NT file servers being programmed with a virus checker program, the virus checker  
7       program in each NT file server being executable by said each NT file server to perform  
8       an anti-virus scan upon file data in random access memory of said each NT file server, a  
9       method comprising:

10            a data mover in the network file server responding to a request from the client for  
11       access to the file in the network file server by applying a filter upon a file extension of the  
12       file upon opening or closing of the file to determine that an anti-virus scan of the file  
13       should be performed, and initiating the anti-virus scan of the file by selecting a next one  
14       of the NT file servers in round-robin fashion and sending to the selected NT file server a  
15       request for the anti-virus scan including a specification of the file, and then  
16            the selected NT file server responding to the request for the anti-virus scan by  
17       invoking the virus checker program in the selected NT file server to perform an anti-virus  
18       scan of the specified file by obtaining file data of the file from the network file server and  
19       storing the file data of the file in the random access memory of the selected NT file server  
20       and performing the anti-virus scan upon the file data of the file in the random access  
21       memory of the selected NT file server.

22

1       18.     The method as claimed in claim 17, wherein the file is an executable file and the  
2     network file server determines that the anti-virus scan of the file should be performed  
3     when the client requests the network file server to open the file and the network file  
4     server finds that the file has not been checked for viruses, and the network file server also  
5     determines that the anti-virus scan of the file should be performed when the client  
6     requests the file to be closed after the client writes to the file.

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8       19.     The method as claimed in claim 17, wherein the operating system of the selected  
9     NT file server supports processes executing in a user mode and processes executing in a  
10    kernel mode, a server for virus checking executing in the user mode receives the request  
11    for the anti-virus scan from the network file server and forwards the request to a virus  
12    checker initiator driver executing in the kernel mode, the virus checker initiator driver  
13    executing in the kernel mode sends a file access call to an input/output manager in the  
14    operating system of the selected NT file server, the input/output manager responds to the  
15    file access call by directing a report of a file access event to the virus checker program in  
16    the selected NT file server, and the virus checker program in the selected NT file server  
17    initiates the anti-virus scan of the file in response to receiving the report of the file access  
18    event from the input/output manager.

19

20      20.     A data processing system comprising:  
21               at least one client;  
22               a first file server coupled to the client for access of the client to at least one file in  
23        the first file server; and

1           at least a second file server coupled to the first file server for data access of the  
2       second file server to the file in the first file server, the second file server being  
3       programmed with a virus checker program, the virus checker program being executable  
4       by the second file server to perform an anti-virus scan upon file data in random access  
5       memory of the second file server;

6           wherein the first file server is programmed to respond to a request from the client  
7       for access to the file in the first file server by determining that an anti-virus scan of the  
8       file should be performed, and initiating the anti-virus scan of the file by sending to the  
9       second file server a request for the anti-virus scan including a specification of the file;  
10      and

11       the second file server is programmed to respond to the request for the anti-virus  
12      scan by invoking the virus checker program to perform an anti-virus scan of the specified  
13      file by obtaining file data of the file from the first file server and storing the file data of  
14      the file in the random access memory of the second file server and performing the anti-  
15      virus scan upon the file data in the random access memory.

16

17     21.   The data processing system as claimed in claim 20, wherein the first file server is  
18       programmed to determine that the anti-virus scan of the file should be performed when  
19       the client requests the first file server to open the file and the first file server finds that the  
20       file has not been checked for viruses.

21

1       22.     The data processing system as claimed in claim 20, wherein the first file server is  
2     programmed to determine that the anti-virus scan of the file should be performed when  
3     the client requests a file to be closed after the client writes to the file.

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5       23.     The data processing system as claimed in claim 20, wherein the first file server is  
6     programmed to apply a filter to a file extension of the file to determine that the anti-virus  
7     scan of the file should be performed.

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9       24.     The data processing system as claimed in claim 20, wherein the first file server is  
10    programmed to block clients from accessing the file from the time that the first file server  
11    determines that the anti-virus scan of the file should be performed until the anti-virus  
12    scan is completed and fails to find a virus in the file.

13

14      25.     The data processing system as claimed in claim 20, wherein the first file server is  
15    programmed to determine that an additional anti-virus scan of the file should not be  
16    performed in response to the access of the file by the virus checker program.

17

18      26.     The data processing system as claimed in claim 20, wherein the first file server is  
19    programmed to maintain in nonvolatile memory an indication of files that have not been  
20    checked for viruses, an indication of files that are in the process of being checked, and an  
21    indication of files that have been found to contain viruses.

22

1       27.     The data processing system as claimed in claim 20, wherein the request for the  
2     anti-virus scan including a specification of the file is an Open Network Computing  
3     Remote Procedure Call.

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5       28.     The data processing system as claimed in claim 20, wherein the second file server  
6     is programmed to receive the request for the anti-virus scan and indirectly invoke the  
7     virus checker program by causing an operating system of the second file server to invoke  
8     virus checker program to perform the anti-virus scan of the file.

9

10      29.     The data processing system as claimed in claim 20, wherein the operating system  
11     of the second file server supports processes executing in a user mode and processes  
12     executing in a kernel mode, and the second file server includes a server for virus  
13     checking that is executable in the user mode and a virus checker initiator driver that is  
14     executable in the kernel mode, the server for virus checking being executable for  
15     receiving the request for the anti-virus scan from the first file server and forwarding the  
16     request to the virus checker initiator driver, and the virus checker initiator driver is  
17     executable for causing the operating system reporting a file access event to the virus  
18     checker program, and the virus checker program is executable for initiating the anti-virus  
19     scan of the file in response to the report of the file access event.

20

21      30.     The data processing system as claimed in claim 29, wherein the operating system  
22     of the second file server includes an input/output manager that is executable in the kernel  
23     mode for receiving a file access call from the virus checker initiator driver, and

1 responding to the file access call by directing the report of the file access event to the  
2 virus checker program.

3

4 31. The data processing system as claimed in claim 20, which further includes at least  
5 a third file server coupled to the first file server for data access of the third file server to  
6 the file in the first file server, the third file server also being programmed with a virus  
7 checker program that is executable by the third file server to perform an anti-virus scan  
8 upon file data in random access memory of the third file server, and wherein the first file  
9 server is programmed for performing a load balancing procedure to select one of at least  
10 the second file server or the third file server to perform an anti-virus scan of the file when  
11 the first file server determines that an anti-virus scan of the file should be performed.

12

13 32. A network file server adapted for coupling to at least one client for access of the  
14 client to at least one file in the network file server, the network file server also being  
15 adapted for coupling to a plurality of secondary servers for access of the secondary  
16 servers to the file stored in the network file server, each secondary server being  
17 programmed with a virus checker program executable for transferring file data from the  
18 file in the network file server to random access memory in said each secondary server,  
19 and performing an anti-virus scan upon the file data in the random access memory of said  
20 each secondary server, the network file server comprising:

21           a cached disk array; and

22           a plurality of data mover computers coupled to the data network and coupled to  
23 the cached disk array for responding to client requests for data access to storage in the

1       cached disk array, wherein at least one of the data movers is programmed to respond to a  
2       request from the client for access to the file in the network file server by applying a filter  
3       upon a file extension of the file upon opening or closing of the file to determine that an  
4       anti-virus scan of the file should be performed, and initiating the anti-virus scan of the  
5       file by applying a load balancing procedure for selecting one of the secondary servers for  
6       performing the anti-virus scan of the file, and sending to the selected secondary server a  
7       request for the anti-virus scan including a specification of the file.

8

9       33.      The data processing system as claimed in claim 32, wherein the file is executable  
10      and the network file server is programmed to determine that an anti-virus scan of the file  
11      should be performed when the client requests the network file server to open the file and  
12      the network file server finds that the file has not been checked for viruses, and the  
13      network file server is also programmed to determine that the anti-virus scan of the file  
14      should be performed when the client requests the file to be closed after the client writes to  
15      the file.

16

17       34.      A secondary server adapted for coupling to a primary server in a data network for  
18      access to data in files in the primary server, wherein the secondary server is programmed  
19      with an operating system supporting processes executing in a user mode and processes  
20      executing in a kernel mode, the operating system including an input/output manager  
21      executable in the kernel mode, wherein the secondary server is further programmed with:  
22                  a server for virus checking executable in the user mode;  
23                  a virus checking driver executable in the kernel mode; and

1           a virus checker program executable in the user mode;

2           wherein the server for virus checking is executable for receiving from the network

3           a request for an anti-virus scan upon a specified file in the primary server, and for

4           forwarding the request to the virus checker initiator driver;

5           wherein the virus checker initiator driver is executable for responding to receipt of

6           the request from the server for virus checking by sending a file access call upon the

7           specified file to the input/output manager;

8           wherein the input/output manager is executable for responding to the file access

9           call by directing a report of a file access event upon the specified file to the virus checker

10          program; and

11         wherein the virus checker program is executable for responding to the report of

12         the file access event by transferring file data from the specified file in the primary server

13         to random access memory in the secondary server, and performing an anti-virus scan

14         upon the file data in the random access memory in the secondary server.

15

16       35.   A data processing system comprising:

17           at least one client;

18           at least one network file server coupled to the client by a data network for access

19           of the client to at least one file in the network file server; and

20           a plurality of NT file servers coupled to the network file server by the data

21           network for data access of the NT file servers to the file in the network file server;

1           wherein the network file server includes a cached disk array and a plurality of  
2        data mover computers coupled to the data network and coupled to the cached disk array  
3        for responding to client requests for data access to storage in the cached disk array;  
4           wherein each of the NT file servers is programmed with a virus checker program,  
5        the virus checker program being executable by said each NT file server to perform an  
6        anti-virus scan upon file data in random access memory of said each NT file server;  
7           wherein at least one data mover in the network file server is programmed for  
8        responding to a request from the client for access to the file in the network file server by  
9        applying a filter upon a file extension of the file upon opening or closing of the file to  
10      determine that an anti-virus scan of the file should be performed, and initiating the anti-  
11      virus scan of the file by selecting a next one of the NT file servers in round-robin fashion  
12      and sending to the selected NT file server a request for the anti-virus scan including a  
13      specification of the file, and  
14           wherein each NT file server is programmed to respond to the request for the anti-  
15      virus scan by invoking the virus checker program in said each NT file server to perform  
16      an anti-virus scan of the specified file by obtaining file data of the specified file from the  
17      network file server and storing the file data of the specified file in the random access  
18      memory of said each NT file server and performing the anti-virus scan upon the file data  
19      of the specified file in the random access memory of said each NT file server.  
20  
21      36.     The data processing system as claimed in claim 35, wherein the file is an  
22      executable file, and the network file server is programmed for determining that the anti-  
23      virus scan of the file should be performed when the client requests the network file server

1 to open the file and the network file server finds that the file has not been checked for  
2 viruses, and the network file server also determines that the anti-virus scan of the file  
3 should be performed when the client requests the file to be closed after the client writes to  
4 the file.

5

6 37. The data processing system as claimed in claim 35, wherein the selected NT file  
7 server is programmed with:

8 an operating system supporting processes executing in a user mode and processes  
9 executing in a kernel mode, the operating system including an input/output manager  
10 executable in the kernel mode;

11 a server for virus checking executable in the user mode; and

12 a virus checker initiator driver executable in the kernel mode;

13 wherein the server for virus checking is executable for receiving the request for  
14 the anti-virus scan from the network file server and forwarding the request to the virus  
15 checker initiator driver;

16 wherein the virus checker initiator driver is executable for responding to the  
17 request from the server for virus checking by sending a file access call to the input/output  
18 manager;

19 wherein the input/output manager is executable for responding to the file access  
20 call by directing a report of a file access event to the virus checker program in the  
21 selected NT file server; and

1           wherein the virus checker program in the selected NT file server is executable for  
2       performing the anti-virus scan of the file in response to receiving the report of the file  
3       access event from the input/output manager.

4

5       38.     A program storage device containing a program executable by a network file  
6       server, the network file server being adapted for coupling to at least one client for access  
7       of the client to at least one file in the network file server, the network file server also  
8       being adapted for coupling to a plurality of secondary servers for access of the secondary  
9       servers to the file stored in the network file server, each secondary server being  
10      programmed with a virus checker program executable for transferring file data from the  
11      file in the network file server to random access memory in said each secondary server,  
12      and performing an anti-virus scan upon the file data in the random access memory of said  
13      each secondary server, the program contained in the program storage device being  
14      executable by the network file server for responding to a request from the client for  
15      access to the file in the network file server by applying a filter upon a file extension of the  
16      file upon opening or closing of the file to determine that an anti-virus scan of the file  
17      should be performed, and initiating the anti-virus scan of the file by applying a load  
18      balancing procedure for selecting one of the secondary servers for performing the anti-  
19      virus scan of the file, and sending to the selected secondary server a request for the anti-  
20      virus scan including a specification of the file.

21

22       39.     The program storage device as claimed in claim 38, wherein the file is an  
23       executable file, and the program contained in the program storage device is also

1 executable by the network file server for determining that an anti-virus scan of the file  
2 should be performed when the client requests the network file server to open the file and  
3 the network file server finds that the file has not been checked for viruses, and the  
4 program contained in the program storage device is also executable by the network file  
5 server for determining that the anti-virus scan of the file should be performed when the  
6 client requests the file to be closed after the client writes to the file.

7

8 40. A program storage device containing a program executable by a secondary server,  
9 the secondary server being adapted for coupling to a primary server in a data network for  
10 access to data in files in the primary server, wherein the secondary server is  
11 programmable with an operating system supporting processes executing in a user mode  
12 and processes executing in a kernel mode, the operating system including an input/output  
13 manager executable in the kernel mode, and the secondary server is also programmable  
14 with a virus checker program for performing an anti-virus scan upon file data in response  
15 to a file opening event being reported to the input/output manager, wherein the program  
16 contained in the program storage device includes:  
17       a server for virus checking executable in the user mode; and  
18       a virus checking driver executable in the kernel mode;  
19       wherein the server for virus checking is executable for receiving from the network  
20 a request for the anti-virus scan upon a specified file in the primary server, and for  
21 forwarding the request to the virus checker initiator driver; and  
22       wherein the virus checker initiator driver is executable for responding to receipt of  
23 the request from the server for virus checking by sending a file access call upon the

- 1 specified file to the input/output manager, whereby the input/output manager directs a
  - 2 report of a file access event upon the specified file to the virus checker program to initiate
  - 3 an anti-virus scan upon file data of the specified file.

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